

# MONTHLY WEATHER REVIEW,

## DECEMBER, 1878.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

### INTRODUCTION.

In compiling the present REVIEW the following data, received up to January 14th, have been made use of, viz: the regular tri-daily weather charts, containing the data of simultaneous observations taken at 119 Signal Service stations and 11 Canadian stations, as telegraphed to this office; monthly journals and means, 109 and 143 respectively, from the former, and monthly means from 13 of the latter; reports from 26 special Sunset stations; 237 monthly registers from Voluntary Observers; 34 monthly registers from United States Army Post Surgeons; Marine Records; International Simultaneous Observations; monthly reports from Voluntary Observers and the local Weather Services of the States of Iowa and Missouri; reliable newspaper extracts; special reports.

### BAROMETRIC PRESSURE.

Upon chart No. II is exhibited by the isobaric lines the general distribution of the atmospheric pressure, as reduced to sea-level, for the month. Compared with the means for December of previous years, the pressure has generally been below the normal, east of the Mississippi; the greatest deficiency (0.05 to 0.11 in.) occurring over the Lower Lake region, Middle States and New England. West of the Mississippi the pressure has generally been above the normal, the greatest excess (about 0.17 in.) occurring in Oregon.

*The Local Barometric Ranges* for the month, as reduced to sea-level, have been largest over the Middle States and New England and least from the Rocky Mountains to California. Taken by districts, they vary as follows: New England, 1.25 in. on summit of Mt. Washington and 1.43 at Eastport to 1.70 at Burlington; Middle Atlantic States, 1.65 at Atlantic City and Norfolk to 1.90 at Fort Whipple; South Atlantic States, 0.96 at Jacksonville to 1.44 at Charlotte, N. C.; Lake region, 1.78 at Rochester to 0.97 at Marquette; Ohio valley and Tennessee, 1.53 at Pittsburgh to 0.94 at Memphis; Gulf States, 0.99 at Mobile to 0.76 at Vicksburg and Laredo, Tex., and 0.52 at Key West; the Northwest and eastern slope of Rocky Mountains, 1.00 at St. Louis to 1.40 at Pembina, 1.47 at Dodge City and 1.19 at Fort Sill; Rocky Mountains, 0.47 at Santa Fé to 0.64 at Denver; Western Plateau, 0.64 at Salt Lake City to 0.70 at Winnemucca; California, 0.70 at Red Bluff to 0.81 at Visalia.

*Areas of High Barometer.*—As usual, for this month, the areas of high pressure have been well marked, and have exhibited a decided influence on the climate of the country. Nine areas merit a brief description. Two (Nos. V and VI) have been remarkable for the persistence shown in remaining on the Pacific coast. Special attention is also called to Nos. II, V, VII, and IX, which, after entering the Gulf States, were accompanied, or rather followed, by storms which probably developed in that vicinity after the cold winds of the high area had begun to blow over the warm and moist surface of the Gulf of Mexico.

No. I.—is a continuation of high area No. IX, described in the November REVIEW. 1st, 7:35 a. m., it extended over New England and the St. Lawrence valley; that day it moved beyond Nova Scotia, with winds veering to southeast in advance of low area No. I, then entering the Lake region.

No. II.—4th, the pressure rose slowly in Texas, while clear weather, with light northerly winds, prevailed in the Gulf States. 5th, the rise extended over the East Gulf and South Atlantic States, but the barometer fell slowly in the Southwest, where the winds veered to warmer southeast in advance of the development in Texas of a storm-centre, charted as low area No. III. 6th, slowly diminishing, the high area was transferred to the Florida region.

No. III.—5th, the barometer rose rapidly in Manitoba. 6th, the rise extended over the Northwest, where it was accompanied by light snows, followed by colder, clearing weather and northwest winds. 7th, the high area moved to the southeast, with maximum pressure central in Virginia. 8th, it was transferred to the Middle Atlantic and New England coast. 9th and 10th, the high barometer, slightly increasing in pressure, moved slowly to Nova Scotia and thence to the Cape Breton region, where it disappeared, with winds veering to southeast in advance of the great storm of the 9th, 10th and 11th, (low area No. III.)

No. IV.—6th, the mercury rose on the Pacific slope. 7th and 8th, an examination of the charts of departures from normal pressures, shows that the high area spread over New Mexico and Arizona. It is interesting to note in connection with this area that it was situated to the northwest of storm-centre (low area No. III) then developing in Texas, while the high area just described (No. III) was situated in the Middle States and New England. These two high areas, 1,500 to 2,000 miles apart, gave rise to a circulation of winds around the centre of depression in Texas favorable to the development of the great energy that storm afterwards displayed.

No. V.—10th, the pressure rose rapidly on the north Pacific coast. 11th, continuing highest in Washington Territory, the barometer rose over all the United States, the greatest rise occurring in the Middle States. 12th, the pressure increased all over the chart, while the highest area extended from Washington Territory to Manitoba and Minnesota. 13th, 14th and 15th, the pressure was above the mean west of the Mississippi, remaining highest on the Pacific coast, but rising only from Southern California to Louisiana. 16th, the area of highest barometer was this day transferred to Manitoba and Minnesota, but over the entire map the pressure was generally above the mean. 17th and 18th, the high area extended from the Northwest to the Gulf States, Tennessee and the Ohio valley. 19th, the isobar of high barometer 30.50 included the country from the Lower Mississippi valley to the Middle and South Atlantic coast. This day a storm of considerable energy was developing in the Southwest, one of less intensity in the Northwest. 20th, diminishing in pressure, the highest area was transferred to the Middle States and New England. 21st, it moved in a northeasterly track beyond Nova Scotia, accompanied by cold northwest winds veering to warmer southeast in advance of storm-centre (No. VI) then entering the Lake region. This high area is remarkable for the large extent of country covered by its isobars of high barometer in its passage from the Pacific to the Atlantic.

No. VI.—This is a continuation on the Pacific coast of the high area (No. V) just described, which on the 16th was transferred east of the Rocky Mountains; but although the maximum pressure had moved to the eastward, still the barometer had remained above the mean in Washington Ty. and Oregon, and the mercury began on the 17th to rise again. 18th, 19th and 20th, the high area remained nearly stationary, generally occupying the region west of the Rocky Mountains. 21st, the pressure remaining highest in Idaho, the barometer generally rose west of the Mississippi river. 22nd, the high area slowly diminishing was transferred to Washington Ty. and Oregon. 23rd, 24th, 25th, 26th and 27th it remained nearly stationary in position. 28th and 29th, it disappeared in advance of a great depression entering the Pacific States from the southwest. This high barometer was remarkable for the persistence it exhibited in remaining over Washington Ty. and Oregon. Its great influence on the climate of that region is shown by a comparison of the means for this month with the same month of previous years. Temperature  $1^{\circ}.5$  below the mean. Rain-fall  $3\frac{1}{2}$  inches deficiency; barometer 0.17 above the mean.

No. VII.—20th, at the midnight report a region of low barometer extended from the Gulf to the north of Lake Superior (low area Nos. VI., VII.). 21st, the mercury rose rapidly west of the Mississippi river. 22nd, the highest area moved into the Gulf States. 23rd, rapidly diminishing in pressure, it moved eastward beyond the Atlantic coast, in advance of the storm-centre developing in the Gulf (No. VIII.).

No. VIII.—23rd, barometer rose very rapidly in the Northwest. 24th, highest pressure 0.5 inches above the mean was transferred to the Indian Territory. 25th, the high area spread over Tennessee and the Ohio valley. 26th, it disappeared in advance of the storm-centre No. VII., then moving over the East Gulf and South Atlantic States. Considered in connection with the snow areas that preceded (Nos. VI. VII.) it was accompanied by high westerly gales and extraordinary snow-storms over the Lakes and adjoining country. The following maximum velocities are reported: Duluth, 30, NW.; Milwaukee, 45, W.; Grand Haven, 50, NW.; Alpena, 26, W. In the Lower Lakes the maximum velocities reported generally exceed 30 miles, but at Buffalo a maximum velocity of 72, W., occurred during a heavy snow-storm. The minimum temperatures of the month, except in the East Gulf and South Atlantic States, occurred during the regime of this high area.

No. IX.—26th, the mercury rose rapidly in Texas, in rear of low-area No. VIII. 27th, it extended over the South and Southwest. 28th, moving to the east, the isobar of high barometer circumscribed the Southern States. 29th, the high area occupied the South Atlantic coast. 30th, it disappeared in front of a low area, then developing in Texas.

*Areas of Low Barometer.*—Eight are described, and all their tracks are charted. The number of storm-areas have been less than the average of December in previous years. Of these, three storms were quite severe; low areas No. I, III, (VI and VII.) Low area No. V appears to have been a secondary development of low area No. IV. Several of the low areas seem to belong to depressions that entered the Pacific coast from the west, but in no case has it been possible to give a reliable charted track of a

depression across the continent. This is in marked contrast with December of 1877, when eight low areas had paths charted over the country, from the Pacific to the Mississippi.

No. I.—is the storm-centre described as No. XIV in the November REVIEW. At the a. m. report of 1st, it was central in western Tennessee. This day, rapidly increasing in energy, the centre moved slowly to the northeast, the pressure at Louisville, Ky., 29.49, being 0.62 below the normal. 2nd, this day the storm-centre moved into the Lower Lake region, and thence into New England. During the forenoon of this day, a special warning was telegraphed to all Middle Atlantic and New England ports. 3rd, pursuing a northeast track, it passed beyond the Gulf of St. Lawrence. It was accompanied in its east and south quadrants on the Atlantic coast by high easterly gales, veering to southerly and thence to westerly, and by heavy precipitation. Cautionary Signals were ordered on the 1st from Jacksonville, Fla., to Eastport, Me., and these were changed on the 2d to Cautionary Off-shore Signals from Macon, N. C., to Cape Henry. The signals were generally justified. The following maximum velocities (measured) are reported: Smithville, 40 SE.; Cape Lookout, 50 SE.; Cape Hatteras, 48 SE.; Kittyhawk, 42 SW.; Cape May, 36 SE.; Atlantic City, 36 SE.; Barnegat, 56 E.; Sandy Hook, 50 SE.; New York, 38 SE.; New Haven, 35 SE.; New London, 69 SE.; Newport, 36 SE.; Wood's Holl, 64 SE.; Boston, 47 SE.; Thatcher's Island, 38 SE.; Portland, 60 SE.; Eastport, 45 SE.

No. II.—2d, appeared first in Manitoba, where the pressure fell 0.7 below the normal. 3d, the centre of depression moved in a southeast track into southern Michigan. 4th, with diminishing energy it marched in an easterly path to Nova Scotia. This storm in the east portions of its track covered much of the country traversed by low area No. I, and rapidly followed it. The precipitation accompanying this depression was light. Rain fell in the advanced quadrants, which changed into snow after the winds veered to colder northwest. Only brisk winds were reported.

No. III.—5th, a great depression entered the North Pacific States. An examination of the Map of departures from the normal pressures shows it crossed the Rocky Mountains on the 6th, but with no well defined centre. 7th, the barometer fell generally from Manitoba to the Gulf, with one centre of depression in Texas, and a second centre in Dakota, both included in the same region of low barometer. 8th, the low area moved slowly to the east, extending from Lake Michigan to the Gulf, the pressure being in this region more than 0.3 below the normal. As this was to prove the severest storm of the month, it is interesting to note the meteorological conditions that existed at the end of this day. A high barometer covered the Rocky Mountain region and its eastern slope, where cold northerly winds prevailed with clear weather; and a second high barometer, occupied the Atlantic coast, where the winds had generally shifted to easterly. The precipitation had in general been heavy, but confined to the region of low pressure. 9th, rapidly increasing in energy, the storm-area moved slowly east, the lowest pressure being from Lake Erie to Georgia. From midnight to the morning of the 10th the storm developed a great increase of energy. The barometer fell in the Middle States, an average of 0.4 inches, and at Norfolk the pressure was 1.02 inches below the normal. At 7:35 a. m., the vortex of the storm was of great extent, nearly covering the States of Pennsylvania, Virginia and North Carolina; in these States the winds were calm, or light and variable, while a fierce southeast gale prevailed on the Middle Atlantic and New England coast. 4.35 p. m., the storm still increasing in energy, the centre occupied the Middle States, where the pressure was generally below 29.00 inches; the following exceedingly low barometers are reported at that hour: Washington, 28.72, 1.40 inches below normal; Baltimore, 28.73, 1.39 below normal; Philadelphia, 28.83, 1.29 below normal; New York, 28.82, 1.23 below normal, while the pressure had rapidly fallen at the centre of the storm in its progress to the east, it had continued to rise slowly at Cape Breton and over the Gulf of St. Lawrence. The rise in that region was as significant as the fall at the centre of the depression in producing the steep barometric gradient existing from New York to Nova Scotia, as shown by the crowded isobars in the weather map of that day. The gradient indicated the fierce gales that accompanied this storm. 11 p. m., the centre of low barometer moved into New York, where the region of pressure of one inch below the mean was of greater extent than at any previous time during this storm, but the rapid fall of mercury in Nova Scotia greatly diminished the barometric gradient on the New England coast and moderated the existing gales. 11th, pursuing a northeasterly track, the storm-centre moved over the mouth of the St. Lawrence river. In the progress of this storm over the country great damage was caused by wind and flood, which will be noted under special appropriate headings. Reports of frequent marine disasters show this storm extended far out to sea on the Atlantic coast. Cautionary Off-shore Signals were ordered on the 8th at Indianola and Galveston, and justified respectively by 42 N. and 40 N. Cautionary Signals were ordered on the morning of the 8th from Cape Lookout to Sandy Hook, and at the morning report of the 9th from Macon N. C., to Key West, also at the midnight report of the 9th from New York to Portland, Me., and a. m. of the 10th at Eastport, Me. These Signals were changed to Cautionary Off-shore from Smithville, N. C., to New York on the 10th and from New Haven to Portland on the 11th. The Cautionary displays were justified by the following maximum velocities, (measured:) Key West, 40, NW.; Savannah, 36, W.; Charleston, 34, SE., 35 W.; Smithville, 48 S., 38 W.; Cape Lookout, 51 S., 64 W.; Cape Hatteras, 64 S., 64 SW.; Kittyhawk, 48 S., 44 SW.; Cape Henry, 36 S., 36 SW.; Cape May, 40 SE., 64 W., Barnegat, 44 S., 43 W.; Sandy Hook, 52 S., 47 W.; New York, 48 SE., 32 NW.; New London, 67 SE., Newport, 38 SE., 36 W.; Woods Holl, 48 SE., 50 W., Thatcher's Island, 44 SE., 41 SW.; Boston, 52 SE., 34 W.; Portland, 60 SE.; Eastport, 44 SE.

Nos. IV and V.—12th, southeast winds, falling barometer, increasing cloudiness, followed by rain on the West Gulf coast gave indication of the approach or formation of a storm centre in Texas. 13th, 7:35



a. m., the veering of winds to northeast in Western Texas indicated the centre shown in the chart. This day the depression moved in a northeast track to western Tennessee and the winds in Texas shifted to high and cold northerly. 14th, the storm-centre moved into the Lake Ontario country. 15th, it disappeared beyond the Gulf of St. Lawrence with ill-defined track. The movement of depression No. IV was quite rapid and the precipitation had been confined in an unusual degree to the centre of the low area. The barometer continued to fall to the east of its charted track, and the rain belt also moved to the east and there was developed a secondary depression, No. V, whose centre is first charted on the morning of the 15th, near Augusta, Ga., though at that time, a region of low barometer extended from New England to Florida. This depression rapidly pursued a northeasterly track, leaving the coast near Cape Henry, moved nearly parallel to the Gulf stream, and is located on the morning of the 16th near Halifax, N. S. The precipitation was general, but not abundant. The high winds reported were of short duration and confined to the Middle Atlantic and North Carolina coast. These storms, taken together are interesting, since the development of the second depression may have been mainly due to the rapidity of the march of the centre of the first low area.

No. (VI and VII).—These two low areas are described together, although they developed in portions of the country far distant, but, as will be seen from their charted tracks the depressions approaching each other were united on the morning of the 21st in the Ohio valley. 17th, there was a general fall in pressure in the Rocky Mountain region, the barometer being most below the normal at Salt Lake. 18th, the low area occupied nearly same position with a slight fall of pressure in Texas. 19th, a decided fall in Texas, where the precipitation and circulation of the winds, showed the formation of a storm-centre. There was a more decided fall of barometer in the Northwest, but a great deficiency in precipitation. 20th, this day the centres of depression marched slowly to the eastward, No. VI moving along the West Gulf coast, and No. VII remaining in Minnesota while there was a marked decline in pressure from the Upper Lakes to the East Gulf. The precipitation in the Gulf States was very abundant, but in the Upper Lakes and the Northwest, although general it was light. 21st, 7:35 a. m., after midnight there was a fall in pressure in the Ohio valley averaging 0.4 inch, and the two low areas became united in a single depression central near Cincinnati, Ohio. 4:35 p. m., the storm centre was over Lake Erie, but southerly gales prevailed on the North Carolina coast, and high southeasterly gales on the Middle Atlantic coast. 11 p. m., New York State was the region of lowest barometer, easterly gales had extended along the New England coast, but on the Middle Atlantic and Carolina coast the wind had shifted to high westerly. 22d, the storm-centre moved along the St. Lawrence valley, and into the Gulf beyond. Cautionary Signals were ordered for this storm, 18th, at Indianola and Galveston, 20th, from Savannah to Kittyhawk, N. C., 21st, from Cape Henry to Eastport; these were changed to Cautionary Off-Shore Signals, 21st from Smithville to Kittyhawk, N. C., and from Baltimore to Wood's Holl, 22d, from Boston to Eastport. The following maximum velocities (measured) are reported: Indianola, 40 N.; Galveston, 30 NW.; Smithville, 36 W.; Wilmington, 43 SW.; Cape Lookout, 44 S.; Cape Hatteras, 48 SW.; Kittyhawk, 40 S.; Cape May, 38 SE., 48 W.; Atlantic City, 36 SE.; Barnegat, 40 SE.; Sandy Hook, 47 SE., 48 W.; New York, 28 SE.; New London, 35 SE.; Wood's Holl, 48 SE., 58 W.; Thatcher's Island, 36 SE., 36 W.; Boston, 40 E., 35 W.; Portland, 44 E., 32 W.; Eastport, 40 SE.

No. VIII.—24th, the barometer was high and rising in the Southwest, and a severe "norther" with cold rain or sleet prevailed on the West Gulf coast. 25th, the pressure slowly diminished in the Gulf States, and the circulation of the winds in the Gulf marked the development of a storm centre. 26th, 7:35 a. m., the centre of depression was situated southwest of New Orleans. This day the storm-centre moved, with great rapidity, to the northeast as charted. 27th, 7:35 a. m., it passed beyond the limits of the map. It was accompanied by general but light precipitation in the Gulf and South Atlantic States. The winds were high and from the north on the Texas coast elsewhere were only brisk.

## INTERNATIONAL METEOROLOGY.

On chart No. IV are shown the probable tracks of storm-centres over the oceans, as follows: *Atlantic*—No. I, as previously given; No. II is the extended track of area No. IV, given under International Meteorology in the November REVIEW. No. III is the extended track of area No. IV of the October REVIEW; No. IV is the extended track of area No. VI, given under International Meteorology in the November REVIEW, and which probably joined the following area; No. V is the extended track of area No. IX, October REVIEW; No. VI is the extended track of No. VII, given under International Meteorology in the November REVIEW; No. VII is the extended track of area No. III of the November REVIEW. *Caribbean Sea*—November 24th and 28th, a violent hurricane reported south of St. Thomas, W. I.; at midnight of December 1st, the schooner Thos. Pickering was reported driven ashore by hurricane on reef 35 miles NNE. of Saona Island, near St. Domingo. December 1st and 2nd heavy E. and SE. squalls at Navassa. At Colon, Panama, a severe "norther" commenced on morning of the 4th and continued until the 10th, accompanied by heavy rains and floods; at 7 p. m. of the 10th, a second "norther" commenced, lasting until the 14th; much damage resulted from these storms. *Pacific*.—No. I, W. to NW. "typhoon;" No. II, November 15th to 19th; No. III, November 22nd and 23rd, hurricane, barometer 28.18; No. IV, November 28th and 29th; No. V, December 3rd to 6th. *Indian Ocean*.—Mauritius, "during a barometric depression which passed over this island, between September 28th and October 8th, severe gales occurred in 36° to 44° S. and 20° to 42° E.; the wind at Mauritius veered from SE. to E., NE., &c., round the compass."

Reports from St. Michael's, Alaska, received at this office for the year ending June 30th, 1878, contain the following items: *July*.—16th, SW. gale all day, ending abruptly about noon of the 17th; 29th and 30th, high winds from SW. and W. *August*.—28th, N. gale commenced, reaching 60 miles per hour on the 29th; high winds occurred on the 2d, 12th, 13th, 15th, 17th, 22d and 28th; faint aurora on the 10th. *September*.—23rd, a northerly gale commenced, lasting until 26th, and reaching 52 miles per hour on the 25th; high winds on the 1st, 2nd, 14th and 22nd; snow on the 11th, first of season, observed on hills about 10 miles distant, a few flakes falling at station 12th, 13th, 18th and 19th; 14th, thin ice on pools; frost on 13 days. *October*.—Gales on the 12th and 13th, NE., 16th, E'ly, 19th and 20th, S'ly, 21st, N., 24th, N., and 26th, E.; snow on 12 days, 6 inches on ground at end of month; ice on pools, 7th; skating, 14th; forming on bay, 15th; 22nd, large part of bay covered, temperature of water 30°; 28th, several inches thick near shore, natives crossing inner part of bay; 31st, ice breaking up and snow disappearing; aurora observed on the 11th, 12th and 13th; on the 7th most of the fresh-water fowl had left, and on the 15th, "the only birds remaining, except the winter residents, were a few sandpipers, gulls and cormorants." *November*.—Gales on the 1st, E'ly 40, 4th and 5th, N. 60, 9th, S. 63, 11th and 12th, E. to NE. 67, barometer 28.89, 21st, N. 40, 24th, NE. 43, 27th, NE. 47; snow on 5 days, eight inches on ground at end of month; freezing every day; aurora, 7th and 26th. *December*.—Gales on 2nd, —57; 21st, S., 46; 28th and 29th, N., 41; snow on eight days, twelve inches on ground at end of month; "winter set in, bay frozen across;" auroras, 5th and 31st. *January*.—Gales on the 1st, E., 40; 11th and 12th, NE., 48; 22nd, N'ly, 53; snow on five days, fifteen inches on ground at end of month; mirage 30th. *February*.—Gales on the 8th, 9th and 10th, NE., 43; snow on three days, twenty-three inches on ground at end of month; auroras, 5th, 26th and 27th; mirage observed on five days. *March*.—Gale on the 29th, 30th and 31st, NE., 40; snow on four days, fifteen inches on ground at end of month; 23rd to 25th, first thaw of season; 25th, showers on distant mountains; mirage observed on five days. *April*.—Gales on the 5th and 6th, S. to E., 43; 25th, S. to E., 54; snow on sixteen days, eighteen inches on ground at end of month; 17th and 18th, thawing rapidly; 19th, freezing; 26th, first wild goose seen. *May*.—3d, severe S. gale, with heavy snow, S., 73 miles; snow on two days; only scattered patches on ground at end of month; rain on ten days; 12th, snow rapidly disappearing; 14th, lakes opening rapidly; 16th, lakes all open and many birds arriving; 18th, much water on ice in bay; 30th and 31st, high tides in morning; ice cracking; 31st, vegetation springing up rapidly and nearly all migratory birds returned; 19th first swallow; freezing nearly every night; 13th, severe frost; 9th, mirage all day, elevating into view capes 60 or 70 miles away, and showing open water 15 to 20 miles southward, also on 10th, 11th and 30th. *June*.—No gales; twelve rainy days; 7th and 8th, ice moving out of bay; 10th, all out of inner bay; first trader from Yukon; 11th, natives arrived in boat from northern end of Sound; 15th, ice all gone; 25th, much large floating ice from seaward; 30th, but little ice; one or two snow-drifts still on mountains; month very cold, and vegetation backward.

#### Summary.

DATE.	BAROMETER.			TEMPERATURE.				Relative Humidity.	Prevailing wind.	Total Monthly movement, in miles.	Rain-fall and melted snow.	DAYS			Depth of snow.*
	Mean.	Max.	Min.	Mean.	Max.	Min.	Range†					On which rain fell.	On which snow fell.	Cloudy.	
1877—July *	29.85	30.18	29.52	56° 4	75°	41°	23°	83	SW	1,312‡	0.67	8	0	12	0
August	29.74	30.09	29.36	53° 4	67°	42°	16°	90	S	7,381	2.48	19	0	24	0
September	29.80	30.46	29.19	40° 8	61°	21°	23°	87	N	8,339	2.23	11	5	20	0
October	29.77	30.26	29.14	28° 6	45°	4°	17°	90	S	10,134	0.37	1	12	22	6
November	29.47	30.25	28.60	15° 7	41°	—1°	21°	85	N	9,425	0.52	1	5	14	8
December	29.46	30.17	28.95	1° 9	33°	—36°	33°	98	S	10,377	0.11	0	5	10	13
1878—January	29.45	30.04	28.57	1° 4	30°	—47°	36°	99.6	NE	7,295	0.11	0	5	11	15
February	29.46	29.99	28.57	—0° 2	28°	—53°	42°	98	NE	5,784	0.12	0	2	8	23
March	29.61	30.01	29.05	—0° 6	41°	—36°	42°	95	NE	6,385	0.12	0	4	7	15
April	29.61	30.21	28.95	21° 6	43°	—17°	35°	90	E	8,215	0.44	0	16	25	18
May	29.64	30.34	28.98	34° 1	55°	5°	31°	89	NE	6,119	2.69	10	2	20	—
June	29.74	30.11	29.26	46° 3	64°	32°	21°	86	N	6,642	1.40	12	0	17	0

\* From 15th to 31st only † Greatest daily range. ‡ From 25th to 31st only. § Depth of snow on ground at end of month, in inches.

*York Factory, Hudson Bay Territory*.—The observer, (Mr. J. Fortescue,) in submitting reports for June, July and August, states: "all our ships speak of heavy ice in Hudson's Bay, as high as the fore-yards," and thinks that "an ice stream has been liberated from Sir Thos. Roes Welcome, and through the various channels intersecting what was formerly supposed to be Southampton Island, by the two previous mild winters; and that the prevalence of easterly winds all summer has kept it in the bay, where icebergs are rarely seen."

Advices from Point Barrow, dated August 19th, state that nearly all the whaling fleet had arrived there, some as early as the latter part of July, having worked northeastward as fast as the ice opened away from the land; some found much hindrance from ice, and two vessels were lost a few miles south of Point Barrow. August 8th to 11th, there was much drifting ice between Point Barrow and Return Reef; at time of writing the ice which previously had been close to the land from Point Barrow to Point Belcher, 60 miles south, was fast disappearing to the westward, with a continued ENE. wind.

## TEMPERATURE OF THE AIR.

The isothermal lines of chart No. II illustrate the general distribution of the temperature of the air for the month. By reference to the table on the left side of the chart it will be seen that the temperature of the month has been considerably above the mean in New England, and below the mean from the South Atlantic States to the Lower Lakes and westward. The greatest deviation occurs in Colorado and Wyoming, where the temperature is about seven degrees below the mean.

*Minimum and Maximum Temperatures, respectively:—Maine—Mechanics' Falls, —4° and 46°; Gardiner, 5°, 53°; Eastport, 8°, 52°. New Hampshire—Mt. Washington, —15°, 34°; Auburn, —2°, 54°; Vermont—Newport, —14°, 49°; Burlington, 6°, 56°. Massachusetts—Billerica, —1°, 40°; Springfield, 8°, 60°; Boston, 10°, 59°. Rhode Island—Newport, 14°, 56°. Connecticut—Mystic, 0°, 53°; New London, 12°, 57°. New York—Brookhaven, —5°, 58°; Plattsburg Barracks, —1°, 45°; New York City, 12°, 58°; Rochester, 8°, 52°; Buffalo, 6°, 49°; Wappinger's Falls, 12°, 60°. New Jersey—Somerville, 7°, 59°; Atco, 13°, 64°. Pennsylvania—Tarentum, —12°, 46°; Hulmeville, 9°, 64°; Philadelphia, 13°, 62°; Pittsburgh, 4°, 52°. Delaware—Dover, 12°, 60°; Wilmington, 13°, 67°. Maryland—Cumberland, 4°, 48°; New Market, 7°, 60°; Baltimore, 15°, 61°. District of Columbia—Washington, 13°, 60°. Virginia—Wytheville, 5°, 52°; Capeville, 26°, 64°; Lynchburg, 17°, 52°. West Virginia—Helvetia, —2°, 52°; Morgantown, 7°, 54°. North Carolina—Franklin, 0°, 56°; Weldon, 21°, 70°. South Carolina—Aiken, 17°, 67°; Charleston, 25°, 67°. Georgia—Gainesville, 13°, 68°; Savannah, 24°, 73°; St. Mary's, 23°, 74°. Florida—Mayport, 26°, 75°; Key West, 55°, 79°; St. Marks, 25°, 71°. Alabama—Green Springs, 17°, 68°; Montgomery, 22°, 70°. Mississippi—Vicksburg, 20°, 72°. Louisiana—New Orleans, 27°, 70°; Point Pleasant, 23°, 73°. Texas—Fredericksburg, 9°, 81°; Jacksboro', 10°, 72°; Corsicana, 18°, 73°; Galveston, 29°, 71°. Ohio—Bellefontaine, —13°, 44°; Columbus, —7°, 48°; Cincinnati, —1°, 52°. Kentucky—Danville, —3°, 50°; Louisville, 4°, 53°; Bowling Green, —2°, 57°. Tennessee—Austin, —2°, 50°; Memphis, 11°, 63°; Knoxville, 6°, 57°. Arkansas—Judsonia, 9°, 71°. Michigan—Detroit, —4°, 42°; Alpena, 9°, 38°; Grand Haven, 12°, 42°; Marquette, 2°, 40°. Indiana—Spiceland, —14°, 39°; Indianapolis, —12°, 48°; St. Meinrad, 10°, 56°. Illinois—Elmira, —23°, 44°; Anna, —4°, 60°; Chicago, —9°, 46°; Cairo, 4°, 60°. Missouri—Ashley, —17°, 55°; Corning, —13°, 62°; St. Louis, —3°, 56°. Kansas—Fort Hays, —13°, 68°; Independence, —4°, 60°; Dodge City, —3°, 65°. Wisconsin—Neillsville, —18°, 41°; Milwaukee, —8°, 44°; Madison, —8°, 39°. Iowa—Byron, —17°, 46°; Des Moines, —10°, 52°; Keokuk, —13°, 52°; Ames, —15°, 35°. Nebraska—Plattsmouth, —11°, 56°; Omaha, —8°, 59°; Ft. McPherson, —20°, 70°. Indian Territory—Fort Gibson, 3°, 63°; Ft. Sill, 10°, 67°. Minnesota—Ft. Snelling, —12°, 38°; Duluth, —14°, 38°; Breckenridge, —17°, 40°. Dakota—Morrison, —12°, 45°; Bismarck, —20°, 48°; Pembina, —22°, 41°; Yankton, —11°, 55°; Deadwood, —25°, 54°. Colorado—Colorado Springs, —15°, 59°; Denver, —12°, 62°; Ft. Garland, —23°, 51°. Wyoming Territory—Cheyenne, —12°, 56°; Ft. Fred. Steele, —28°, 54°. Utah—Salt Lake City, 8°, 56°. Nevada—Winnemucca, —6°, 65°. California—San Francisco, 40°, 68°; Sacramento, 23°, 66°; Red Bluff, 25°, 71°; Campo, 7°, 80°. New Mexico—Santa Fe, 0°, 65°; Ft. Union, —11°, 61°. Idaho—Boise City, 7°, 53°. Montana—Virginia City, —15°, 46°.*

*Ranges of Temperatures.*—The monthly ranges will appear from an examination of the minima and maxima just given. Greatest daily ranges vary in New England from 18° at Wood's Holl to 33° at Burlington; Middle Atlantic States, 19° at Lynchburg to 29° at Cape Henry; South Atlantic States, 23° at Savannah and Charleston to 30° at Jacksonville; Gulf States, 14° at Key West to 33° at Montgomery and 35° at Corsicana; Ohio valley and Tennessee, 20° at Louisville to 29° at Nashville; Lake Region, 15° at Grand Haven and Buffalo to 29° at Milwaukee; the Northwest 20° at Dubuque and Davenport to 43° at North Platte; Rocky Mountains, 39° at Colorado Springs to 47° at Santa Fe; Western Plateau, 24° at Salt Lake to 43° at Winnemucca; California, 16° at San Francisco to 23° at Visalia and 54° at Campo.

*Frost* has been quite general over the northern sections of the country and interior of the Southern States; at stations along the Gulf and South Atlantic coasts frosts have occurred from five to fifteen days.

*Ice* formed in the Gulf and South Atlantic States and on the Pacific coast as follows:—Denison, Tex., 14th; Laredo, Tex., (16th first,) 25th, 26th, 27th; Montgomery, 19th, 28th; St. Marks, 19th, 28th; Atlanta, Ga., 20th, 26th; Tybee Island, Ga., (23rd, 1 inch, first,) 28th, 1½ in.; Savannah, 23rd, ½ in., 24th, 27th, 28th, 29th; Princeton, Cal., 14th, (16th to 25th, ½ in.,) 26th, ¾ in., 27th, ¾ in., 29th, ½ in.; Green Springs, Ala., 16th to 18th; Mayport, Fla., 6th, ½ in.; Okahumpka, Fla., 28th, ¾ in.; Melissa, Tex., 10th, ¾ in., 23rd, 1 in., 24th, creeks frozen over, 31st, 3 in.; Sacramento, Cal., 8th, 14th to 20th, 22nd, 26th, (27th, 2½ in.,) 29th, 3½ in.; Eagle Pass, Tex., 15th, 16th, 18th, 21st, 25th, 26th; Point Pleasant, La., 16th to 18th, 22nd to 28th; Brookhaven, Miss., 3rd, 4th, 5th, 15th to 18th, 22nd, 23rd, 26th to 28th; Los Angeles, Cal., 12th, 13th, 14th, 18th, 25th; Visalia, Cal., 27th ½ in.

*Ground Frozen.*—The following items will serve to show the occurrence of frost in ground in the same districts: Denison, Tex., 16th; Savannah, 28th, 29th; Green Springs, Ala., 16th to 18th, 22d to 25th, 27th, 28th; Thomasville, Ga., 28th; Melissa, Tex., 15th; Brookhaven, Miss., 15th to 18th, (24th, two in.)

## PRECIPITATION.

On chart No. III is illustrated the general distribution of the precipitation for the month. On the left side is a table giving the average precipitation for December, which shows a decided excess in the northeast districts and the East Gulf States, and a large deficiency on the Pacific coast.



*Special Heavy Rains.*—1st, Clarksville, Tenn., 2.50 in.; Pt. Pleasant, La., 3.01 in. 2nd and 3rd, Dunbarton, N. H., 3.08 in. 8th and 9th, Clarksville, Tenn., 3.00 in.; Pt. Pleasant, La., 7.02 in. 9th, Tybee Island, Ga., 3.41 in. 9th and 10th, White Plains, N. Y., 4.10 in.; Fayetteville, N. C., 6.00 in.; Tioga, Pa., 3.75 in.; Fallston, Md., 4.05 in.; Newark, N. J., 3.99 in.; Auburn, N. H., 4.00 in.; Contoocookville, N. H., 3.00 in. 10th, Mystic, Conn., 2.40 in.; Gardiner, Me., 3.84 in.; Rowe, Mass., 3.00 in.; Ardenia, N. Y., 4.51 in.; Weldon, N. C., 2.44 in.; Tarentum, Pa., 3.00 in.; Cape Henry, Va., 3.07 in. 10th and 11th, Mechanics' Falls, Me., 4.73 in.; Dunbarton, N. H., 4.28 in.; Cape Lookout, 3.66 in.; Oswego, 3.69 in.; 11th, Atco, N. J., 2.52 in.; Boyd's Corners, N. Y., 5.02 in.; North Volney, N. Y., 3.75 in. 19th and 20th, Galveston, 4.79 in.; New Orleans, 2.77 in.; 19th to 21st, Pt. Pleasant, La., 4.81 in. 20th and 21st, Thomasville, Ga., 3.38 in.; Fayetteville, N. C., 6.00 in.; St. Marks, 3.78 in. 21st, Cape Lookout, 4.77 in.; White Plains, N. Y., 2.40 in.; Sandy Hook, 2.72 in. 24th, Pt. Pleasant, La., 2.81 in. 30th, Pt. Pleasant, La., 3.01 in. 31st, Los Angeles, Cal., 3.58 in.

*Largest Monthly Rain-falls.*—Mt. Pleasant, La., 17.69 inches; Fayetteville, N. C., 14.50 in.; Cape Lookout, 11.25 in.; Dunbarton, N. H., 10.63 in.; Oswego, 10.49 in.; Cape Hatteras, 10.20 in.; Mechanics Falls, Me., 9.64 in.; White Plains, N. Y., 9.40 in.; Clarksville, Tenn., 9.25 in.; Galveston, 9.07 in.; Saugeen, 8.86 in.; Mt. Washington, 8.77 in.; Boyds Corner, N. Y., 8.74 in.; Buffalo, 8.55 in.; Ashland, N. H., 8.25 in.; North Volney, N. Y. 8.35 in.; Palermo, N. Y., 8.12 in.; Cape Henry, 8.06 in.

*Smallest Monthly Rain-falls.*—Deep Creek, Utah, and Fort McKavett, Tex., none; Fort Concho, Tex., and Camp McDermit, Nev., trace; Winnemucca, Nev., 0.02 inches; Fort Lyon, Col., 0.10 in.; Salt Lake City, 0.11 in.; Fort Davis, Tex., 0.12 in.; Princeton, Cal., 0.13 in.; Yuma, Ariz., 0.14 in.; Castroville, Tex., 0.17 in.; Dodge City, Kan., and Cheyenne, Wyo., 0.19 in.; Visalia, Cal., and North Platte, Neb., 0.20 in.; Brackettsville, Tex., and De Soto, Neb., 0.24 in.; Omaha, 0.27 in.; Logan, Ia., and Clear Creek, Neb., 0.30 in.; Stockton, Tex., and Burkes, Ariz., 0.31 in.; Sacramento, Cal., 0.47 in.

*Floods.*—Tioga, Pa., 9th, river overflowed, doing considerable damage to roads and bridges. Catawissa, Pa., 12th, river 22½ ft. above low water. Lockhaven, Pa., 11th, Bald Eagle creek overflowed, flooding low part of town. 10th, at Kingston, N. Y., storm most severe in this part of State since 1802. Country flooded; at Eddyville much damage to canal boats and property. Paterson, N. J., at midnight of Tuesday "the flood reached within a few inches of that of 1854, the greatest since 1810, and still rising." Dec. 11, a. m., higher than ever known before; streets inundated from 4 to 5 feet deep; factories, bridges and dams much damaged. Delaware River—at Bordentown, all railroads under water; Trenton, N. J., higher than before known. Susquehanna river—severe floods for fifty miles; Lehigh valley R. R. flooded for miles—1 mile swept away. Albany, N. Y., 11th and 12th, Hudson river overflowed its banks, flooding lower part of city; Mechanics' Falls, 9th to 11th, severe freshets, bridges &c. carried away; 40 feet of railroad track washed away south of Garrison's; tide higher than for years. Springfield, Mass., 11th, Connecticut river rose to 18 ft. 6 in. above low water mark, or highest water since 1854; at Hartford it rose 24 ft. above low water mark, submerging city front. Contoocookville, N. H., 12th, river very high, mills stopped, railroads badly washed, &c. The Merrimac, at Concord, N. H., within one inch of highest water (1869) ever known; railroad tracks submerged and badly washed. West Deerfield, Mass., 50 ft. washout on Troy & Greenfield R. R. Brattleboro, Vt., heavy flood in low part of village. Northampton, Mass., fifty houses flooded; Mill river higher than ever known before. Rapid rises were reported in Cape Fear river, at Fayetteville, on the 9th, 42 feet; on the 21st, 45 feet; and 28th, 42 feet.

*Hail.*—Fort Sill, Ind. T'y, 30th; Camp McDermit, Nev., 6th; Mt. Sterling, Ill., 8th; Creswell, Kan., 13th; Owing's Mills, Md., 21st; New Bedford, Mass., 2d; Linden, N. J., 14th; Somerville, N. J., 4th; White Plains, N. Y., 14th; Flushing, N. Y., 10th; Weldon, N. C., 4th, 20th, 26th; College Hill, Ohio, 4th; North Lewisburg, Ohio, 8th; Pittsburg, Pa., 15th; Ringtown, Pa., 4th; Accotink, Va., 2d; Red Bluff, Cal., 9th; Cheyenne, Wyo. T'y, 3d; Smithville, N. C., 26th; Fort Whipple, Va., 26th; Atlantic City, N. J., 4th.

*Rainy Days.*—The number of days on which rain or snow has fallen, varies as follows: New England, 10 to 18; Middle States, 8 to 17; South Atlantic States, 8 to 14; Gulf States, 6 to 17; Ohio valley and Tennessee, 11 to 26; Lower Lake region, 20 to 28; Upper Lake region, 8 to 23; Upper Mississippi valley, 6 to 21; Lower Missouri valley, 4 to 14; Eastern slope, 3 to 14; Rocky Mountains, 6 to 10; Western Plateau, 2 to 4; Pacific coast, 1 to 15.

*Cloudy Days.*—For New England the number varies from 7 to 24; Middle States, 6 to 19; South Atlantic States, 9 to 15; Gulf States, 5 to 14; Ohio valley and Tennessee, 12 to 23; Lower Lake region, 18 to 31; Upper Lake region, 12 to 29; Upper Mississippi valley, 11 to 22; Lower Missouri valley, 8 to 17; Eastern Slope, 8 to 14; Rocky Mountains, 2 to 9; Western Plateau, 3 to 9; Pacific Coast, 3 to 6.

*Snow.*—West of the Appalachian range the precipitation occurred generally in snow. On the Pacific, Gulf and South Atlantic coast, it occurred as follows: In *British Columbia*, on the 3d, 17th and 18th. *Oregon*—on the coast mountains, 9th. *California*—on the coast mountains, 25th and 29th. *Texas*—interior, 13th, 16th, 17th, 20th, 21st, 25th, 26th, 28th. *Louisiana*, 26th. *Alabama*—interior, 10th, 26th, 27th. *Georgia*—interior, 9th, 10th. *North Carolina*, 4th, 5th, 6th, 17th, 18th, 20th, 21st, 26th and 27th.

*Depth of Snow on Ground at end of Month.*—At the end of the month the country north of a line almost identical with the isotherm of 35°, given on chart No. II, remained covered with snow. It varied in depth in the different sections as follows: In *New England*, from none or a trace along the coast to 9 inches in Vermont and 24 inches in the White Mountains. *Middle States*, trace to 1 inch along coast to 4 inches in

interior. *Western North Carolina and northern Georgia*,  $\frac{1}{2}$  inch. *Tennessee*, none to 2 inches. *Ohio valley*, 2 to 24 inches. *Lower Lakes*, 4 inches to 2 or 3 feet at eastern ends of Lakes Erie and Ontario. *Upper Lakes*, 1 to 2 inches near Lake Superior to 2 or  $3\frac{1}{2}$  feet along eastern shore of Lake Michigan. *Northwest*, generally from 1 to 6 inches, except from Arkansas to Illinois, where it was much deeper, some observers reporting 2 and 3 feet. *Rocky Mountain stations*,  $1\frac{1}{2}$  inch at Santa Fé to  $7\frac{1}{2}$  at Denver and 4 at Virginia City. *Black Hills*, Deadwood, 18 inches.

## RELATIVE HUMIDITY.

The average percentage of relative humidity for the month ranges as follows: New England, 65 to 79; Middle Atlantic States, 62 to 78; South Atlantic States, 65 to 72; East Gulf States, 72 to 79; West Gulf States, 61 to 81; Lower Lakes, 71 to 84; Upper Lakes, 66 to 83; Ohio valley and Tennessee, 65 to 76; Upper Mississippi valley, 70 to 76; Lower Missouri valley, 70 to 85; Red River of the North valley, 84 to 94; Eastern Slope, 61 to 77; Western Plateau, 46 to 59; California, 44 to 59. *High stations* report the following; not corrected for altitude: Cheyenne, 66; Denver, 51; Colorado Springs, 63; Santa Fe, 49.

## WINDS.

The prevailing winds at the Signal Corps stations are shown by arrows on chart No. II. From an examination of which, it will be seen that they have been almost, without exception, from the north or northwest, except in the Lake region, Ohio valley and Atlantic States, where they have been more westerly, and in some instances southwest.

*Total Movements of the Air.*—The following are the largest monthly movements recorded at the Signal Corps Stations, viz: Cape May, 16,567 miles; Wood's Holl, 15,969; Sandy Hook, 15,426; Cape Lookout, 14,227; Thatcher's Island, 13,584; Indianola, 12,428; Barnegat, 11,046; Cape Henry, 10,564; Sandusky, 10,426; Newport, 10,396; Key West, 9,917; Milwaukee, 9,858. The *smallest* are: Visalia, Cal., 1,443 miles; Deadwood, Dak., 1,658; Nashville, 2,853; Salt Lake City, 2,895; Santa Fe, 2,941; Lynchburg, 2,969; Indianapolis, 3,246; Augusta, 3,526; Knoxville, 3,730; Dubuque, 3,565; Eagle Pass, Tex., 3,620; Los Angeles, 3,906.

## VERIFICATIONS.

*Indications.*—The detailed comparison of the tri-daily weather Indications with the telegraphic reports for the succeeding twenty-four hours, show the general percentage of omissions to be 1.4 per cent., and of verifications to be 87.1 per cent. The percentage of verifications for the four elements have been: weather, 93.6; wind, 84.4; temperature, 86.5; barometer, 83.8. The percentage of verifications by geographical districts have been: New England, 88.6; Middle States, 87.0; South Atlantic States, 85.5; East Gulf States, 90.1; West Gulf States, 88.6; Lower Lake Region, 87.1; Upper Lake Region, 88.4; Tennessee and the Ohio Valley, 85.5; Upper Mississippi Valley, 85.2; Lower Missouri Valley, 84.6. Of the 3,667 predictions that have been made, 118 or 3.2 per cent. are considered to have entirely failed; 141 or 3.8 per cent. were one-fourth verified; 361 or 9.8 per cent. were one-half verified; 281 or 7.7 per cent. were three-fourths verified; 2,766 or 75.5 per cent. were fully verified, so far as can be judged from the tri-daily weather maps.

*Cautionary Signals.*—During the month 187 Cautionary Signals were displayed; 155 or 82.9 per cent. were justified by subsequent hourly velocities of 25 miles or over at, or within 100 miles of, the station.

*Cautionary Off-shore Signals.*—50 signals, not included in the above, were ordered up as Cautionary Off-shore Signals; 36, or 72.0 per cent., of these were justified, both as to velocity and direction. 78 Cautionary Signals were changed to Cautionary Off-shore Signals, and, as to direction, 67 or 85.9 per cent. were justified; as to velocity they are considered with the cautionary. 68 cases were reported, generally from scattered stations, of winds of 25 miles or over where signals were not ordered.

## NAVIGATION.

In the table, on right side of chart No. III, are given the highest and lowest readings, on the Signal Corps, river-gauges, during the month, with dates of same.

*Ice on Rivers and Lakes.*—*Missouri*—Fort Randall, Dak., 24th, river closed by ice; Yankton, 13th, closed by ice; Omaha, 18th, closed by ice; Croning, 18th, closed by ice; Leavenworth, 11th to 14th, much floating ice,—17th, gorge formed one mile below,—18th, frozen over; Lexington, 23rd, closed; Booneville, 27th, closed. *Mississippi*—St. Paul, 14th, frozen over; La Crosse, 7th, first floating ice,—11th, ice gorged,—12th, river closed; Dubuque, 2nd, last boat of season left, latest closing of navigation since 1857,—7th, full of floating ice,—17th ice-gorge,—18th, frozen over,—23rd, teams crossing; Fulton, 9th, ice stopped running; Le Claire, 14th, frozen over, people crossing; Davenport, 7th, first floating ice,—14th shore ice,—18th, navigation closed,—20th, frozen over,—26th, teams crossing; Muscatine, 8th, floating ice, 19th, closed,—23rd, teams crossing; Burlington, 9th, first ice in river,—10th to 13th, floating,—13th, navigation entirely suspended,—16th, frozen over; Ft. Madison, 18th, river closed; Keokuk, 7th, much floating and shore ice,—10th, canal closed,—20th, ice 8 to 10 inches thick,—27th to 31st, floating and shore ice; St. Louis, 15th to 23rd, floating ice,—17th, navigation suspended,—24th, gorged and frozen over, people crossing; Cairo, 23rd to 31st, river frozen. *Maquoketa*—Monticello,



Iowa, 20th, frozen over. *Des Moines*—Boonsboro', 19th, frozen over. *Spring River*—Empire City, Kans., 18th, closed with ice,—31st, ice 14 inches thick, "hardest frozen ever known." *Rock River*—Rockford, Ills., 7th, 8th and 18th, frozen over,—13th and 15th, partly frozen; Sterling, 6th and 7th, frozen over. *Ohio*—Pittsburgh, 25th, both rivers frozen over. Cincinnati, 19th, canal frozen over; 20th, ice four inches thick; 24th, river full of floating ice, impeding navigation; 25th to 31st, all southern packets laid up, ferries stopped. Louisville, 25th, canal frozen; 26th, navigation closed; 30th, river full of floating ice. Cairo, 25th to 31st, floating ice. *Licking River*—Cincinnati, 23d, frozen over; 30th, ice 8 inches thick. *Monongahela*—Morgantown, 26th, river frozen  $\frac{1}{2}$  inch thick; 27th, ice two in. thick; 28th to 31st, ice 3 in. thick. Pittsburgh, 23d, floating ice; 25th, frozen over. *Alleghany*—Pittsburgh, 19th and 21st, floating ice; 25th, frozen over. *New River*—Wytheville, Va., 25th, river and Barret's mill dam frozen over. *James River*—Dover Mines, Va., 27th and 28th, frozen over; 29th, ice moving; 26th to 31st, canal frozen and navigation suspended. *Potomac*—Washington, 26th and 28th, river frozen. *Susquehanna*—*North Branch*—Catawissa, 25th, frozen over; navigation closed on the 11th, owing to damages caused by high water. *Delaware*—Trenton, 8th, canal frozen over, first time this season; 14th, river frozen over. Philadelphia, 19th, ice forming; 20th to 25th, floating ice. *Hudson*—Albany, 11th, floating ice, 23rd, frozen over, navigation closed; Ardenia, 27th, navigation closed; West Point, 25th, frozen over; Wappinger's Falls, 24th, floating ice, 28th, navigation closed, 31st, ice 9 inches thick. New York, 26th, much floating ice in rivers. *Long Island Sound*—Flushing Creek, 23rd, navigation closed, 27th, ice 6 inches thick. *Thames River*—New London, 27th, frozen over. *Penobscot River*—Bangor, Me., 7th, ice forming, 8th, frozen over. *Lake Superior*—Duluth, 23rd, ice in inner harbor  $\frac{1}{2}$  inch thick, lake free during rest of month; Ashland, 15th, Long Island bay closed by ice; Marquette, 20th and 29th, ice in harbor. *Lake Michigan*—Escanaba, 16th, ice around docks, 29th, bay frozen over; Embarrass, Wis., 1st, rivers closed; Manitowoc, 7th, rivers closed; Chicago, 16th, navigation closed, 24th, river frozen over, people crossing. *Monono Lake*, Wisconsin.—7th, bay frozen over, 16th, lake frozen over. *Mendota Lake*, Wisconsin.—22nd, frozen over, 31st, ice 16 to 25 inches thick. *Geneva Lake*, Wisconsin.—26th, frozen over, horses and ice-boats on ice. *Lake Huron*—Port Huron, 15th, navigation closed, 24th, ice-floes in St. Clair river. *Lake Erie*—Toledo, 20th, river frozen over; Sandusky, 14th, ice along docks, 18th, bay entirely frozen over; Cleveland, 15th, navigation closed, 16th, first ice in river, 17th, first ice on lake, 18th, canal frozen over, 20th, river frozen over. Buffalo, 7th, navigation closed, 28th, lake frozen as far as visible with glass. *Niagara River*—Ft. Niagara, 24th to 31st, river half to nearly full of floating ice. *Lake Ontario*—Rochester, 1st, lake navigation closed; 7th, navigation closed on Erie canal; Oswego, 1st, navigation closed; Madison Barracks, 27th, bay frozen over. *Otsego Lake*, N. Y.—31st, partially frozen over. *Lake Massabesic*, N. H.—17th, frozen over. *Lake Winnepiseogee*, N. H.—27th, closed by ice. *Cape Lookout*, N. C.—28th, sound frozen nearly half a mile out. *Cape May*—24th, ice in Egg Harbor.

*High Tides*.—Coney Island, 10th, bathing-houses, &c., washed away; Eastport, Me., 23rd, tides very high, overflowing wharves; Newport, R. I., 23rd, unusually high, overflowing wharves in some parts of the city; Wappingers Falls, N. Y., 2nd, 10th to 12th.

*Low Tide*.—Cape Lookout, N. C., 26th, lowest known tide in sound for fourteen years.

## TEMPERATURE OF WATER.

The temperatures of water, as observed in rivers and harbors, with average depth of observations, is given on Chart No. III. At the following stations, observations were discontinued on account of ice, on the dates named: December 15th, at Buffalo; 16th, Escanaba; 18th, Chicago and Cleveland; 19th, Marquette; 20th, Toledo; 22nd, Grand Haven and Detroit; 24th, Sandusky. Observations were resumed at Marquette on the 25th and continued until the 28th; they were interrupted at Cleveland on the 2nd, 4th, 5th, 7th and 10th to 12th by rough water.

## ATMOSPHERIC ELECTRICITY.

*Thunder-storms*.—Gulf Hammock, Fla., 24th, Independence, Kan., 7th; Brookhaven, Miss., 9th; Weldon, N. C., 10th; Aiken, S. C., 26th; Melissa, Tex., 7th; Red Bluff, Cal., 6th; Smithville, N. C., 26th; Cape Lookout, N. C., 2nd.

*Auroras*.—Bangor, Me., 1st; Boston, 1st; Eastport, Me., 1st, 26th; Pembina, Dak., 23rd, 24th; Cornish, Me., 24th; Gardiner, Me., 16th; Orono, Me., 15th, 16th; Cambridge, Mass., 16th, 19th, 23rd; Fall River, Mass., 16th; Dunbarton, N. H., 19th; Contoocookville, N. H., 16th; Freehold, N. J., 24th; Atco, N. J., 25th; Jacksonburg, Ohio, 27th; Cincinnati, 3rd; North Lewisburg, Ohio, 13th; Brownsville, Pa., 11th to 14th; Woodstock, Vt., 16th; Embarrass, Wis., 1st; Yankton, Dak., 1st; Starkey, N. Y., 16th.

## OPTICAL PHENOMENA.

*Solar Halos*.—1st, Md., N. J., N. Y., Pa. 2d, Nev. 4th, Tex. 6th, Cal., Neb., Kan. 7th, Ill., Ia., Ohio, Tenn. 8th, Cal., Tex., Conn., N. J., N. Y. 9th, Me., Cal. 71th, Tex., Ohio, Nev. 12th, Ia., Neb. 13th, Ind., Ohio. 14th, Ia., Ga., S. C. 16th, Fla., Kan., Ohio, Vt., Nev. 17th, Minn., Fla., Col., Mass., Mo., Neb. 18th, Dak., Kan., Mo., N. H. 19th, Ia., N. Y., Ohio. 20th, Ia., Kan. 21st, Ia., Ohio, Dak. 22d, Ia., Dak. 23d, Ia., Fla., Dak., Kan., Me., Neb., W. Va., Nev. 24th, Ia., Vt., Dak., Kan., Neb. 25th, Ill., Ia., Dak., Kan., Ohio. 26th, Ia., N. Y. 27th, Ia., Ohio. 28th, Ill., Ia., Wis. 29th, R. I., Mass., N. H., N. Y. 30th, Dak., Va. 31st, Ia.

*Lunar Halos*.—1st, Iowa, Cal., Neb., Md., Mass., R. I., N. Y., Pa., Wis., Dak. 2nd, Ill., Ind., Cal. Nev., N. M., Cal., Kan., Iowa, Ohio, Ky., Nev., Neb., N. J., Wis. 3rd, Cal., Col., Tex., Dak., Ill., Tenn. N. J., R. I., Conn., Mo., Neb., N. Y., Va., Wis. 4th, Cal., Nev., Tex., Minn., Ill., Mass., R. I., Dak., Mo., N. J., N. Y., Ohio, Va. 5th, Ind., Cal., N. M., Iowa, Minn., Tenn., N. J., Conn., Neb. 6th, Cal., Neb., Kan., Miss., Ill., Mass., Conn., Mo., Tex., Va. 7th, Ill., Ind., Iowa, Dak., Wis., Mich., Ohio, W. Va., Mass., Maine, Mo., Va. 8th, Iowa, Cal., Nev., Minn., Mich., N. Y., Mass., Conn., Vt., Dak., Mo., Neb. 9th, Col., Neb., Kan., Me., Utah. 10th, Cal., Col., Iowa, N. J., La. 11th, Iowa, Tex., Minn., Ohio. 12th, Iowa, Minn., Ohio, Conn., Wis. 13th, Ind. 14th, Cal., S. C. 16th, Cal. 17th, Nev., Mo. 18th, N. M. 19th, N. M. 20th, Va. 21st, Neb. 26th, Iowa. 28th, Ill., Iowa. 29th, Ill., Cal., Wis. 30th, Ill., Cal., Nev., Tex., Dak., Wis., Minn., Tenn., N. C. 31st, Ill., Iowa, Neb., Wis., Minn., Ind., Conn., N. J., N. Y., Pa., Va.

*Mirage*.—Burlington, Vt., 15th, 26th; New London, Conn., 8th, 12th, 17th; McPherson, Bks., Ga., 12th; Princeton, Cal., 15th; New Bedford, Mass., 1st, 13th; Genoa, Neb., 29th to 31st.

*Rainbow*.—Washington, D. C., 26th, 10:20 a. m., rainbow observed in zenith.

## MISCELLANEOUS PHENOMENA.

**BOTANICAL**.—*Massachusetts*—Somerset, ground open and farmers plowing until the 15th. *Kansas*—Independence, 11th, farmers plowing. *North Carolina*—Fayetteville, 31st, Japonicas budding, violets in bloom. Wilmington, 31st, roses in full bud, one in bloom; geraniums in garden still green. *Utah*—Camp Douglass, grass and clover remained fresh and green until the 7th.

**BIRDS**.—*Geese*—Winnemucca, Nev., 5th, flying SW.; Des Moines, Ia., St. Louis, 16th, S.; Newport, R. I., 11th, NW.; Somerset, Mass., 23rd, S.; Fall River, Mass., 23rd, S. in large numbers; Corning, Mo., 24th, 26th; Oregon, Mo., 5th, 8th; Clear Creek, Neb., during month; Howard, Neb., 27th, S.; Flushing, N. Y., 8th, N.; Melissa, Tex., 5th, 9th; Riley, Ill., 9th, SE. *Snow-birds*—Monticello, Ia., 19th, 29th; Oregon, Mo., 4th, 8th, 13th, 15th; Contoocookville, N. H., 4th. *Blackbirds*—Oregon, Mo., 8th. *Woodpeckers*—Monticello, Ia., 10th. *Bluejays*—Monticello, Ia., 8th. *Ducks*—Daytona, Fla., 1st, flying S.; Monticello, Ia., 4th, S.; Creswell, Kan., 2nd, 5th, 30th; Oregon, Mo., 4th, 5th; Palermo, N. Y., 5th, S. *Tree Sparrows*—Somerset, Mass., numerous during month. *Owls*—Norfolk, Ohio, hooting 27th.

**METEORS**.—Cheyenne, Wy. T'y, 16th, 9 p. m., large meteor moving south to north, elevation 45°. North Platte, Nebr., 26th, 9:50 p. m., small but very brilliant meteor moving from zenith to about 15° above NE. horizon, where it exploded, trail of light smoke vanished almost instantly. Davenport, Iowa, 27th. Toledo, 30th. Morgantown, 30th, 7:10 p. m., remarkably brilliant meteor fell from a point a little west of south, at an altitude of about 60°; color deep blue, changing to white, then golden, then crimson; path nearly perpendicular to the horizon; exploded within 20° of the horizon, remained visible 15 seconds; 7:20 p. m., small meteor in same path, leaving blue trail. Indianapolis, 28th. Savannah, 12th. Fort Whipple, Va., 30th, 7:10 p. m., very brilliant meteor, altitude about 40° above NW. horizon, following a vertical downward course until its disappearance; at about 20° above the horizon there spread out from it a tail resembling that of a comet, of a rich vermilion color; its motion was comparatively slow, remaining visible for about two seconds. Bangor, Me., 1st. Princetown, Cal., 12th, very large meteor, moving from east to west, light equal to half daylight, train visible several seconds. Monticello, Iowa, 12th. Cresco, Iowa, 12th. Woodstock, Md., 5th, 6th, 11th, 12th, 16th, 25th. Rowe, Mass., 22d. Oregon, Mo., 5th, 17th. Freehold, N. J., 2d, 19th. Atco, N. J., 22d. Linden, N. J., 6th. Waterburg, N. Y., 20th. Wappinger's Falls, N. Y., 20th, 25th, 30th. Flushing, N. Y., 29th, 30th. Fayetteville, N. C., 8th, 27th. Westerville, Ohio, 12th, 15th. Jacksonburg, Ohio, 30th. Tioga, Pa., 30th. Fallsington, Pa., 15th. Wytheville, Va., 12th. Yankton, 4th. Castroville, Tex., 6th.

**ZODIACAL LIGHT**.—Savannah, 22nd, 23rd, 25th; Newburg, Vt., 19th; New Corydon, Ind., 6th, 7th, 23rd, 26th, morning, 25th, morning and evening; Monticello, Ia., 28th, evening; Somerset, Mass., 13th, 14th, 16th, 18th to 20th, 22nd, 23rd, 24th, evening; Cambridge, Mass., 14th, 16th, 19th, 23rd, 24th, 25th, evening; suspected 18th, 22nd; Fall River, Mass., 18th, evening; Oregon, Mo., 23rd, 24th, evening; Atco, N. J., 16th to 18th, 20th, 22nd to 24th, evening, 24th, 28th, morning; Waterburg, N. Y., 20th, evening; Bellefontaine, Ohio, 12th; Wytheville, Va., 24th, 25th, 27th; Southington, Conn., 16th, 23rd to 25th; Washington, D. C., 17th, 6 p. m., 18th, 6:30 p. m., 19th, 6 p. m., faint, 20th, 6:15 p. m., extending 90° from the sun, 21st, cloudy, 22nd, 6 p. m., suspected, 22rd, 7:30 p. m., certain, but faint—long and narrow, 23rd, 5:30 a. m., bright, 23rd, 6 p. m., bright—extending 90° from sun, 24th, 6 p. m., bright, sparsely defined—extending 80° from sun, 25th, 6:15 p. m., bright, broad, ill-defined—axis passes south of Venus by several degrees, 26th, cloudy, 27th, 6 p. m., moonlight—dark disk, remarkably bright: 28th, clear—moonlight—dark disk not very bright, 29th, cloudy, haze, 30th, moonlight.

**POLAR BANDS**.—Leavenworth, Kan., 16th; Dubuque, Iowa, 29th; Milwaukee, 7th; Savannah, 8th, 19th; Wilmington, N. C., 2nd, New Corydon, Ind., 7th; Taber, Iowa, 29th; Guttenburg, Iowa, 7th, 31st; Danville, Ky., 12th, 13th; Gardiner, Me., 19th, 27th; Plattsmouth, Neb., 6th; Clear Creek, Neb., 1st, 2nd, 3rd, 6th, 7th, 9th, 20th; Auburn, N. H., 1st, 8th; Wytheville, Va., 7th, 8th, 12th, 13th, 18th, 19th, 29th.

**PRAIRIE FIRES**.—Keokuk, Iowa, 5th; New Orleans, La., 18th; Eagle Pass, Tex., 3rd, 17th.

**EARTHQUAKES**.—San Jose de Costa Rica, October 31st, 9:30 a. m., very feeble shock. November 3d, 5:30 p. m., feeble shock; 8th, 8:15 p. m., feeble shock; 23d, quite strong shock. U. S. Naval Hospital, Yoko.

hama, Japan, November 5th, 0h 57', light shock; 10th, 1:47 a. m., light shock. Alajuela, Costa Rica, November 26th, 1:40 a. m., earthquake of short duration. Red Bluff, Cal., December 9th, 3:20 p. m., severe shock, lasting 15 to 20 seconds, motion upward and downward. Flushing, N. Y., 24th, 9 p. m., slight shock from N. to S., lasting five minutes and accompanied by a low, rumbling noise.

**Sunsets.**—The characteristics of the sky at sunset, as indications of fair or foul weather for the succeeding twenty-four hours, have been observed at all Signal Corps Stations. Reports from 103 stations show 3,173 observations to have been made of which 36 were reported doubtful; of the remainder 2,630 or 82.9 per cent., were followed by the expected weather.

**Sun Spots.**—Monthly record of observations by Mr. D. P. Todd, Nautical Almanac office, Washington D. C., communicated by Prof. S. Newcomb, U. S. Navy, in charge of that office:

Dec., 1878.	No. of new—		Disappeared by solar rotation.		Reappeared by solar rotation.		Total number visible.		Remarks.
	Groups	Spots.	Groups	Spots.	Groups	Spots.	Groups	Spots.	
6th, 4 p. m...	0	0	0	0	0	0	0	0	
11th, 2 p. m...	0	0	0	0	0	0	0	0	
12th, 2 p. m...	0	0	0	0	0	0	0	0	
13th, 3 p. m...	0	0	0	0	0	0	0	0	
16th, 2 p. m...	0	0	0	0	0	0	0	0	
18th, 4 p. m...	1	1	0	0	0	0	1	1	Faculae; spot small.
19th, 2 p. m...	0	0	0	0	0	0	1	1	Faculae.
24th, 3 p. m...	0	0	1	1	0	0	0	0	
28th, 2 p. m...	0	0	0	0	0	0	0	0	
30th, 2 p. m...	0	0	0	0	0	0	0	0	

Mr. Jay Harcourt, at Wappinger's Falls, N. Y., examined the sun on the following days, but observed no spots: 1st, 4th, 8th, 14th, 16th, 19th, 21st, 25th, 30th, 31st. Mr. David Trowbridge, at Waterburg, N. Y., examined the sun on the following days, but observed no spots: 1st, 2nd, 3rd, 5th, 6th, 8th, 12th, 13th, 18th, 22nd to 24th, 29th to 31st. Observations were also made at Ft. Whipple, Va., from the 20th to the 31st, and no spots observed.

## NOTES AND EXTRACTS.

In the *American Journal of Science and Arts* for January, 1879, Professor Loomis publishes his Tenth Paper of "Contributions to Meteorology." With respect to storms of the Atlantic ocean, he has examined seventy-seven cases of low areas near the coast of the United States, and was able to follow thirty-six of them, with considerable confidence, entirely across the Atlantic Ocean, but eight of the storms became merged with other storms before reaching the European coast, leaving only twenty-eight low areas which reached the coast of Europe. Prof. Loomis examines the seventy-seven depressions, with respect to their first appearance, lowest isobars, respectively, in longitudes 60°, 30° and 0° W. of Greenwich; average velocities between those longitudes respectively, and the highest wind with the direction, on the English coast, at the approach of each low area. From his examination, he concludes:

"We see from this table that in one year there are on an average only eighteen different storms which can be traced by means of Hoffmeyer's charts from the coast of the United States across the Atlantic. If for each day we had two good charts, instead of only one, it is probable that a few more storms might be identified in their progress across the ocean, but it is doubtful whether the number would be greatly increased. Nearly all of these storms pursued a course north of east, and passed considerably to the north of Scotland. In only four of the cases did the low centre cross the meridian of Paris in a latitude as low as the northern boundary of England. The average track of the thirty-six low centres which are traced across the ocean, is shown by the means at the bottom of the table, where it is seen that the meridians of 60°, 30° and 0° were crossed in the latitudes 49°6, 58°0 and 63°3. Since the storm-centres generally passed 800 miles north of London, most of them did not exhibit much violence on the English coast. In half of the cases, the highest velocity reported was 3, denoting a very fresh breeze, and in only six of the cases was the velocity at any station on the English coast as high as 5, denoting a gale."

"We may hence conclude that when a centre of low pressure (below 29.5 inches) leaves the coast of the United States, the probability that it will pass over any part of England is only one in nine; the probability that it will give rise to a gale anywhere near the English coast is only one in six; and the probability that it will give rise to a very fresh breeze is one in two."

"One of the most noticeable circumstances connected with Atlantic storms is their slow rate of progress. This is due partly to the erratic course of the centre of the low area, and partly to the frequent blending of two low areas into one, whence it generally results that the most eastern centre appears to be pushed backward toward the west. In my eighth paper I have described a remarkable example of this kind of movement. In like manner the storms numbered 35, 39, 41, 51, 53, 70 and 72 of the preceding table appeared to be pushed westward by blending with storms of subsequent date. Aside from this cause of detention, there seems in the Atlantic ocean to be a special cause which frequently holds storms nearly stationary in position from day to day, and this cause is probably the abundance of warm vapor rising from the Gulf stream, in close proximity to the cold dry air from the neighboring coast of North America. Hence we see that when American storms are predicted to appear upon the European coast, and it is assumed that they will cross the ocean at the same rate as they have crossed the United States, such predictions will seldom be verified."



"It will also be noticed that the storms which cross the Atlantic, generally increase in intensity after leaving the American coast; the average depression of barometer shown in the preceding table being 6 millimeters (0.24 inch) greater in long. 30° than in long. 60°."

Prof. Loomis also makes an examination of the barometer and winds at the base and summit of Mount Washington, and also compares the results with data obtained from adjoining stations, and draws the following conclusion:

"1. High winds on Mount Washington circulate about a low centre as they do near the level of the sea. 2. The motion of the wind is nearly at right angles to the direction of the low center. 3. The low centre at the height of Mount Washington sometimes lags behind the low centre at the surface of the earth apparently as much as two hundred miles."

In the latest edition of the *Encyclopædia Britannica*, William B. Carpenter, F. R. S., on the temperature of the Atlantic, holds that the deep-sea temperature sounding has justified the doctrine of a *vertical* oceanic circulation, sustained by opposition of temperature only, quite independent and distinct from the *horizontal* circulation produced by the winds. His views are expressed as follows:

"1. That instead of the local depressions of bottom-temperature imputed by previous writers to polar currents, the temperature of every part of the deep sea-bed in communication with either of the polar areas would be not many degrees above that of the polar areas themselves."

"2. That this general depression of bottom-temperature would be found to depend, not upon such a shallow glacial stream as might be maintained to be a return from the polar areas of water propelled towards them by wind-currents, but upon a creeping flow of the whole under-stratum, having a thickness of from 1000 to 2000 fathoms."

"3. That as the depression of bottom-temperature in any part of the general oceanic basin would be proportional to the freedom of communication between its deeper portion and that of one or other of the polar areas, the bottom-temperature of the South Atlantic would probably range downward to 32°, while that of the North Atlantic would not be below 35°, except where it first receives the Arctic flow, or comes under the influence of the Antarctic underflow, which would very probably extend itself to the north of the equator."

"4. That as the Arctic and Antarctic underflows must meet at or near the equator, whilst the surface-stratum is there continually being draughted off thence towards either pole, there would be a continual ascent of glacial water under the line, showing itself by a nearer approach of cold water to the surface in the *inter-tropical* than in the *extra-tropical* zone."

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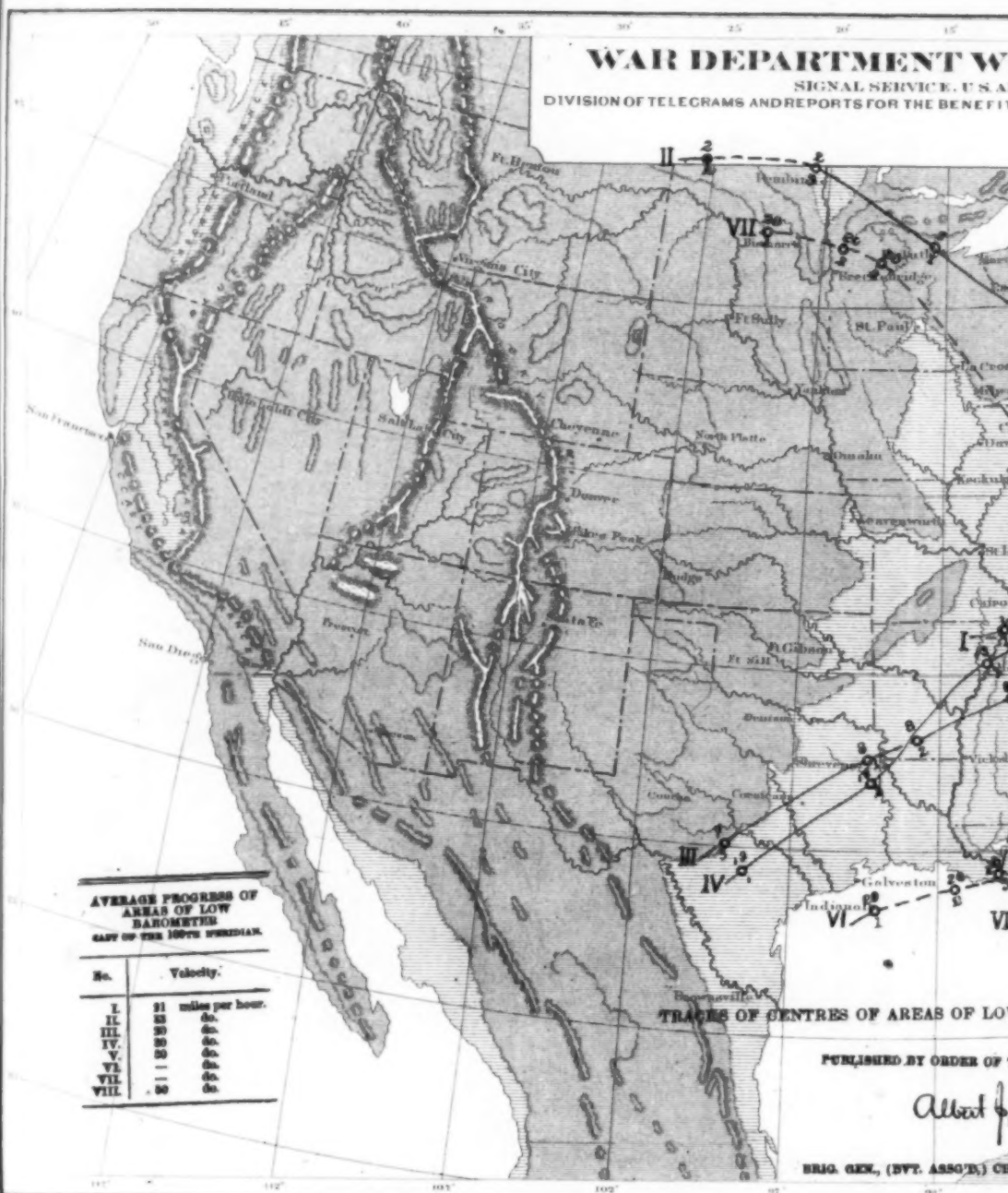
Albert J. Myer

Brig. Gen. (Bvt. Assg<sup>d</sup>.) Chief Signal Officer, U. S. A.

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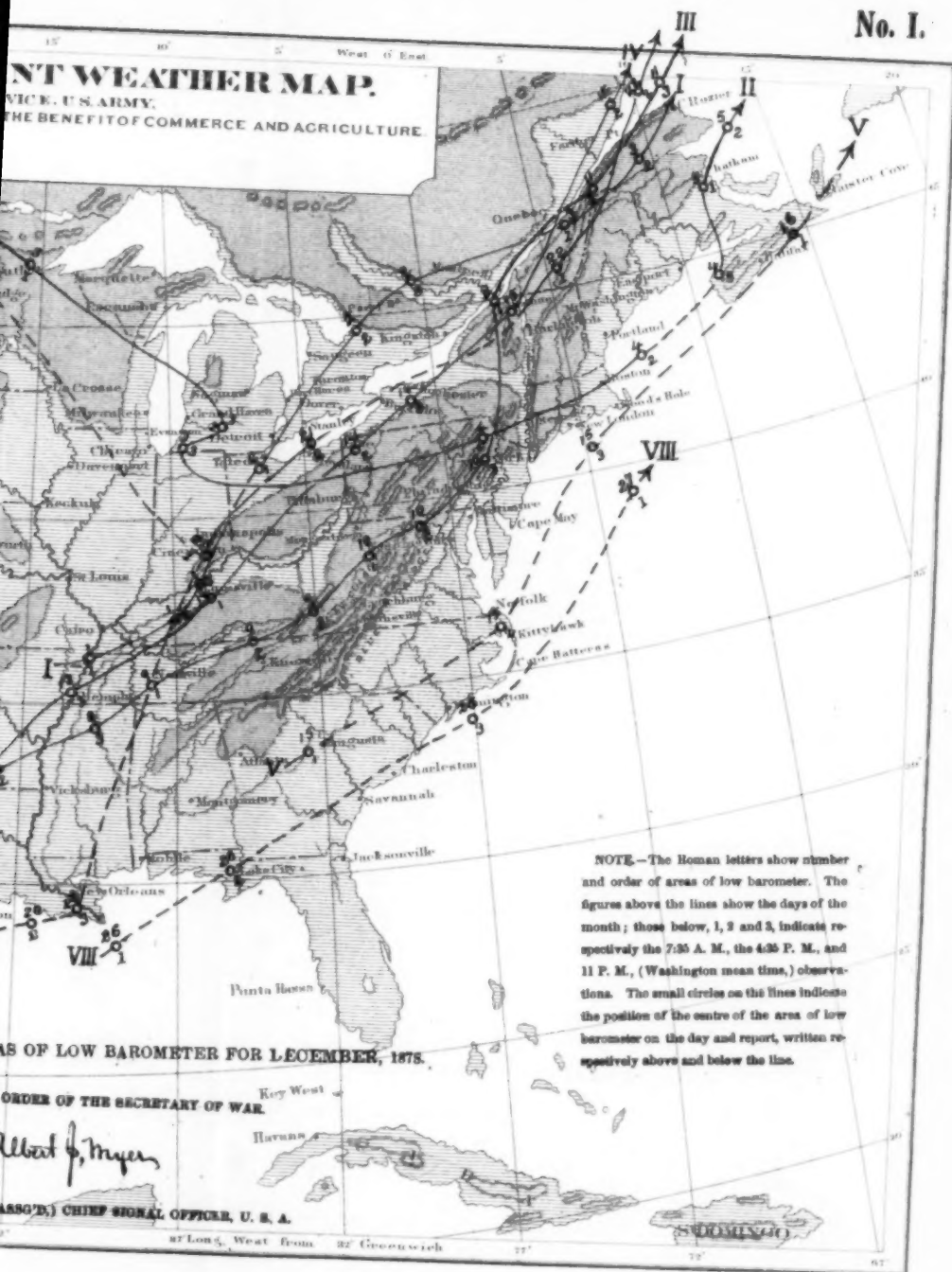


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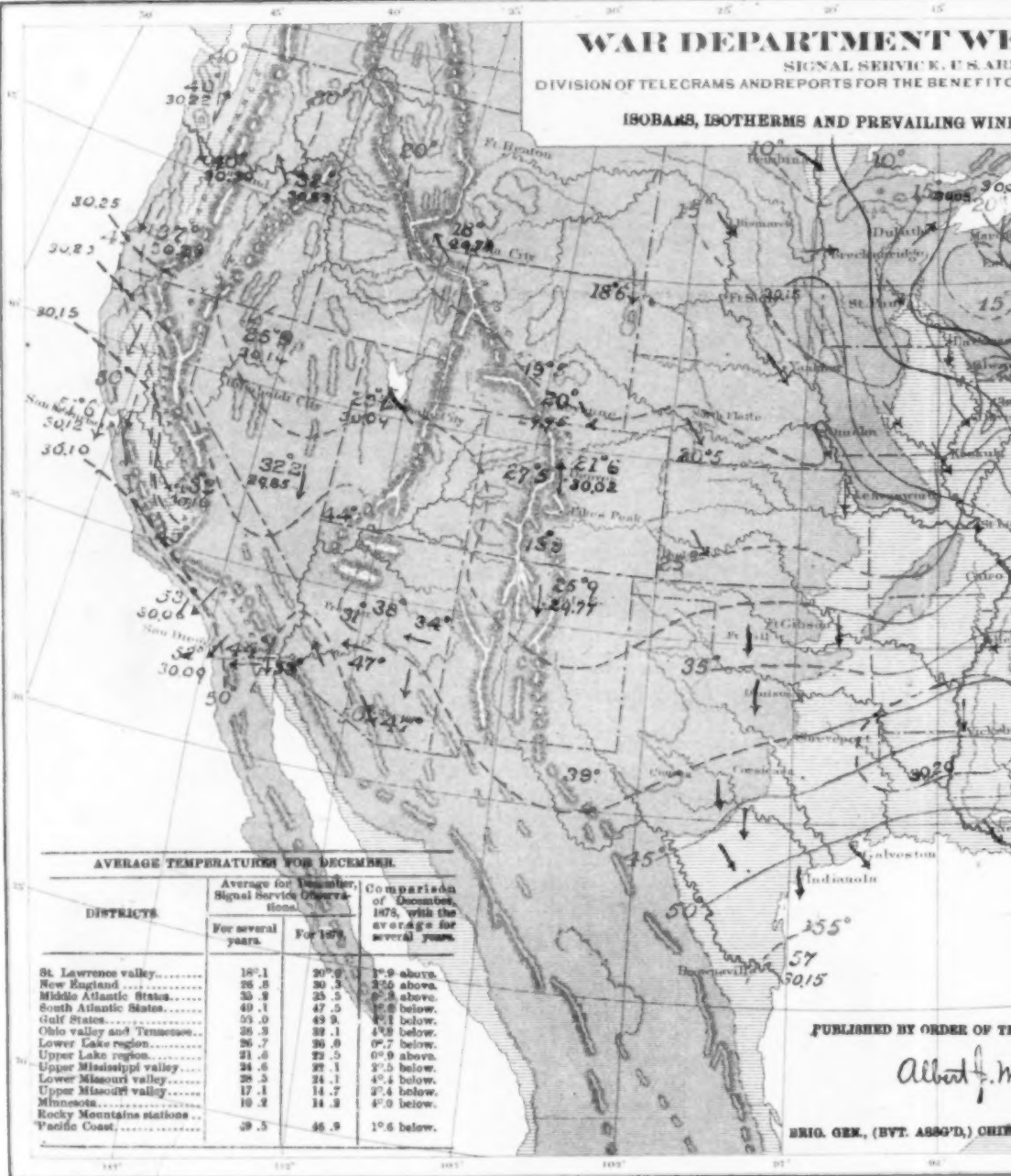


**ANT WEATHER MAP.**  
 VICE, U.S. ARMY,  
 THE BENEFIT OF COMMERCE AND AGRICULTURE.



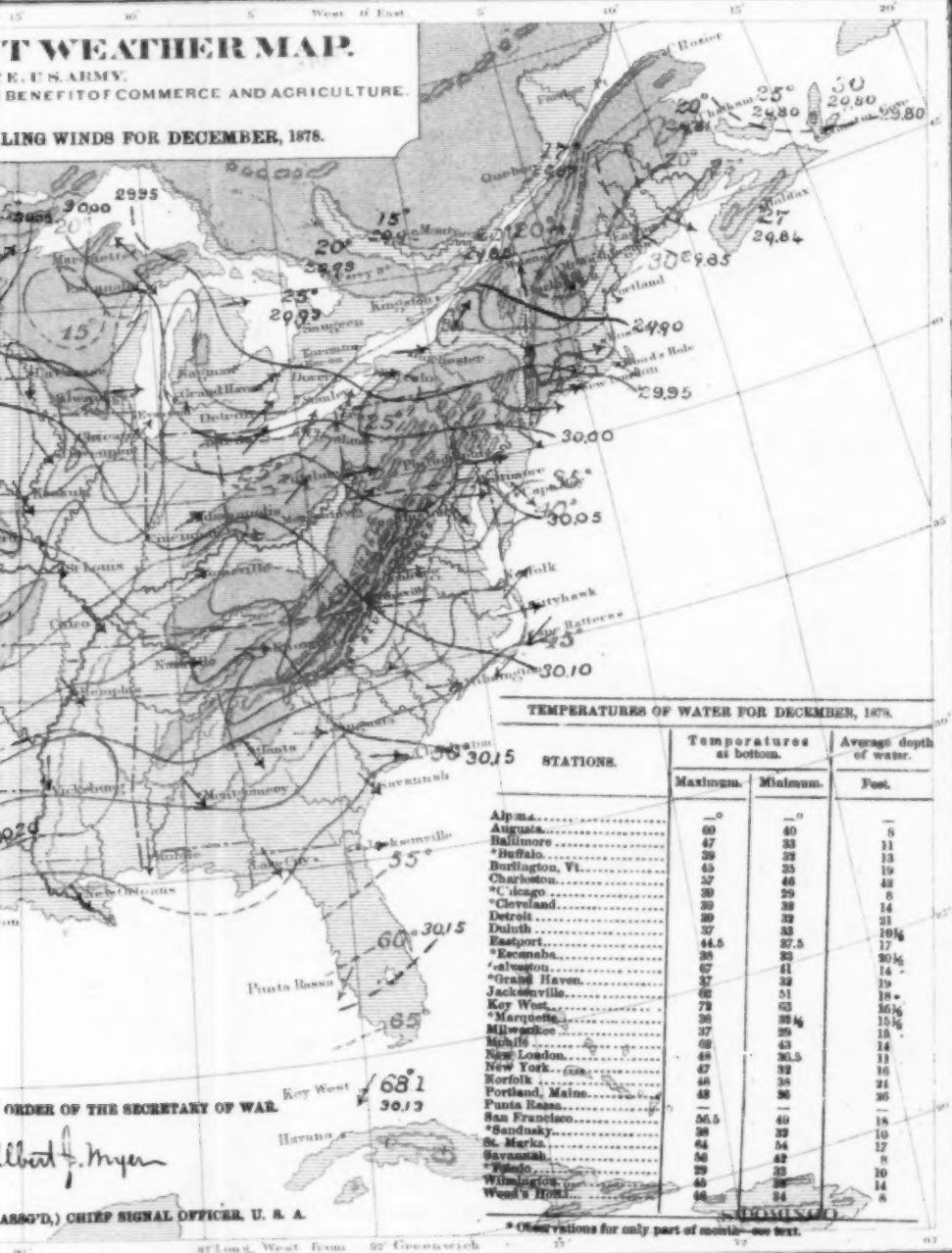
# WAR DEPARTMENT SIGNAL SERVICE, U.S.A. DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF

## ISOBARMS, ISOTHERMS AND PREVAILING WINDS



# No. II.

**WEATHER MAP.**  
 U. S. ARMY.  
 BENEFIT OF COMMERCE AND AGRICULTURE.  
 LING WINDS FOR DECEMBER, 1878.



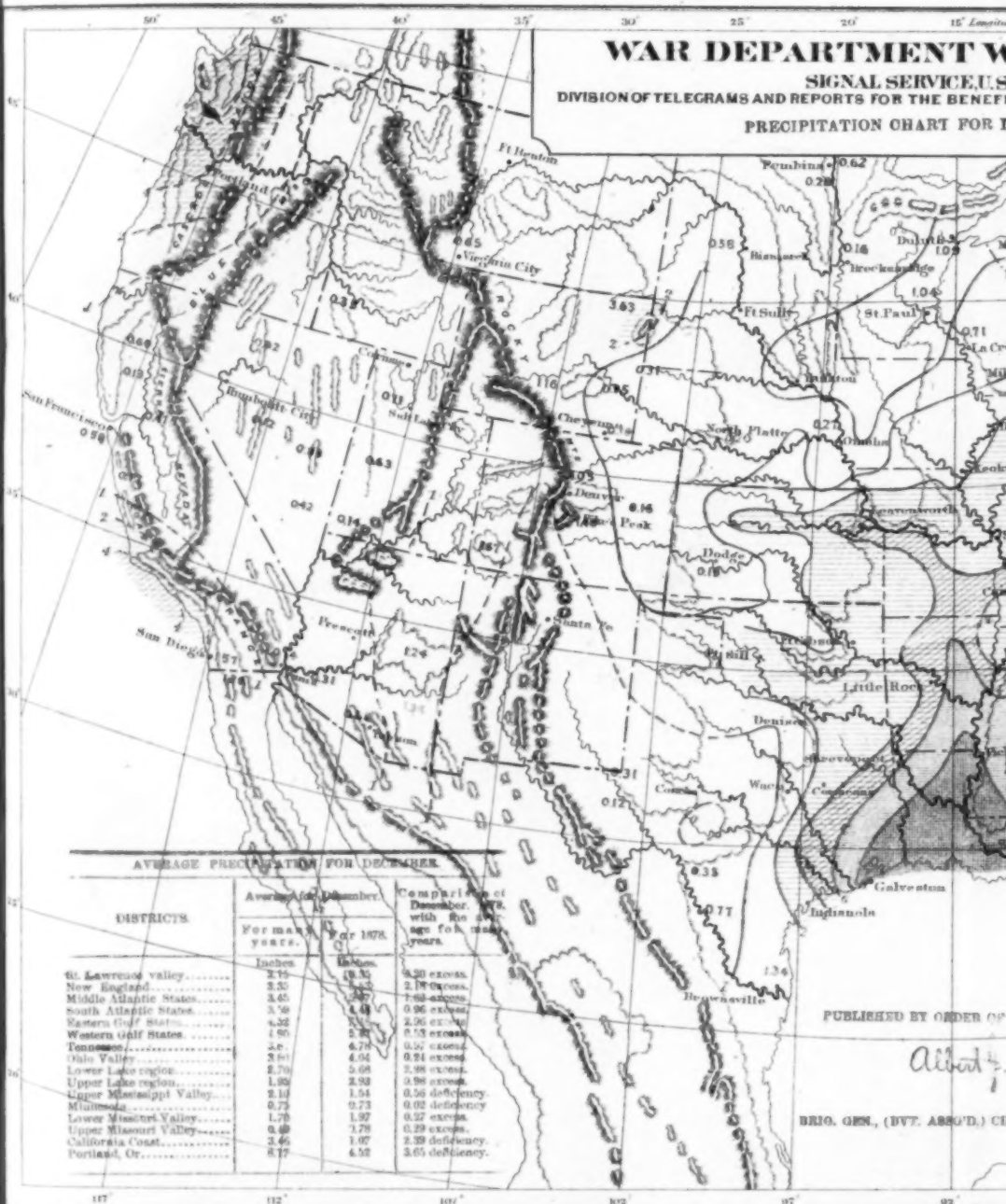
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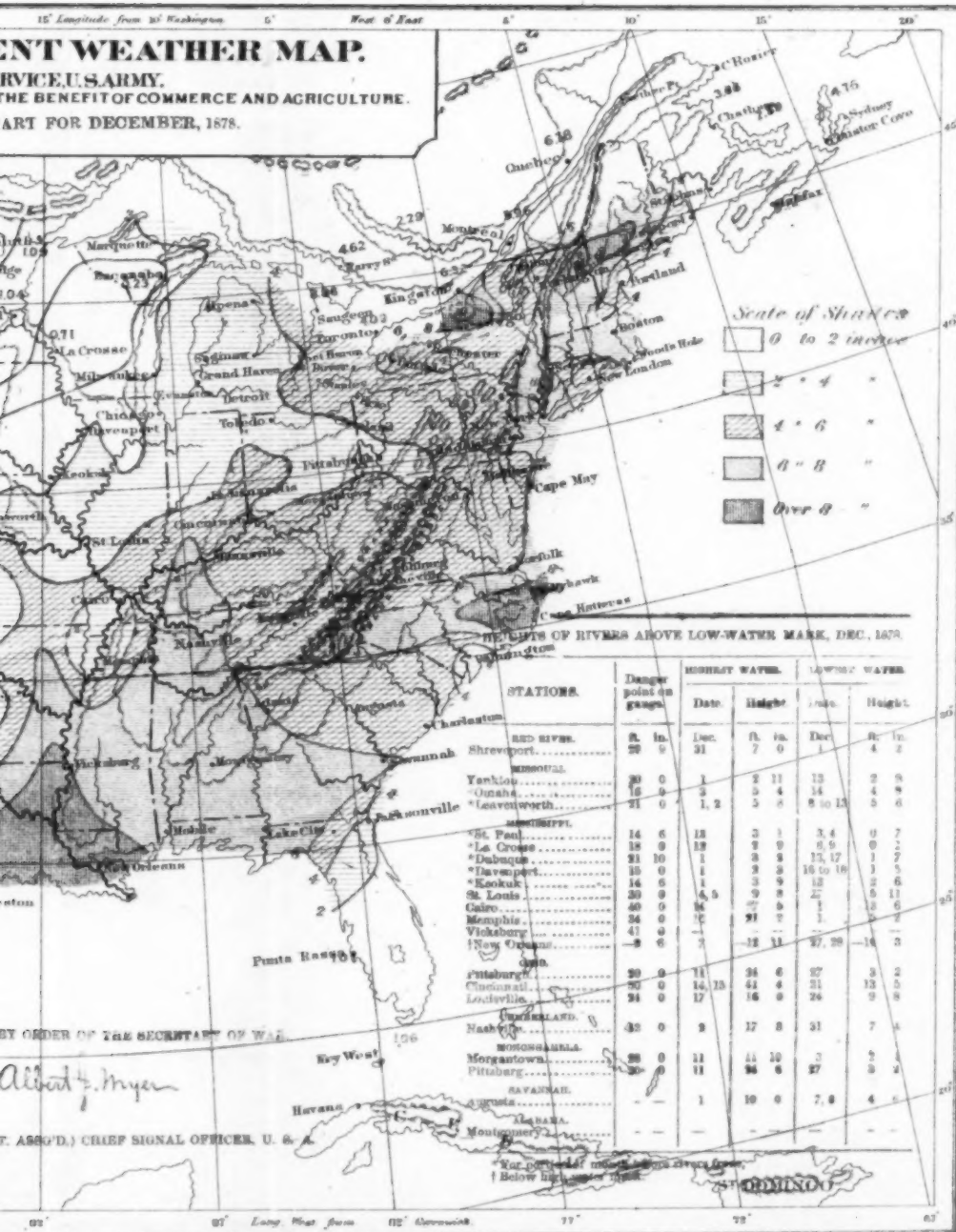
Albert J. Myer

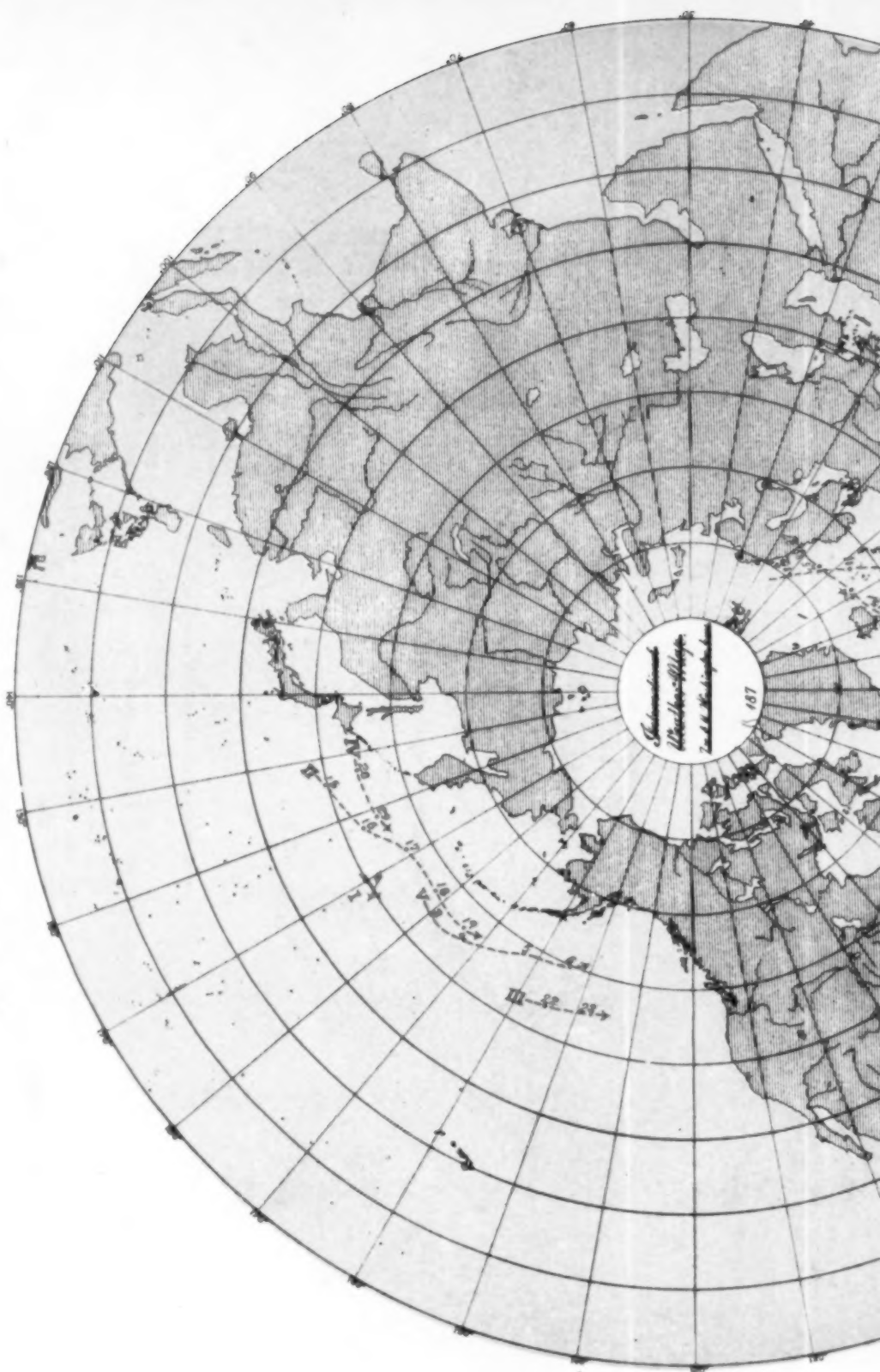
CHIEF SIGNAL OFFICER, U. S. A.

at Long, West from 82° Greenwich













# INTERNATIONAL METEOROLOGY—OCEAN STORM-TRACKS.

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Broken or dotted lines indicate that the lines so broken are doubtful.

Arrows, when charted, fly with the wind and exhibit wind-direction.

The tracks charted in black have appeared in previous *Reviews*.

The tracks charted in red have been made from data collected since preceding *Review*.

*Albert J. Myer*

MAJ. GEN. (REV. ASST. CHIEF SIGNAL OFFICER, U. S. A.)

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